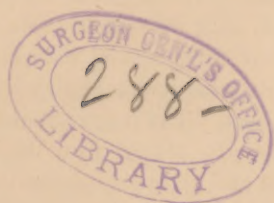


James (J.F.) Compliments of the  
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## PROTOZOA OF THE CINCINNATI GROUP.

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The term Protozoa is applied to those members of the animal kingdom which are "generally of minute size, composed of a nearly structureless jelly-like substance (termed 'sarcode') showing no composition out of definite parts or segments, having no definite body-cavity, presenting no traces of a nervous system, and having either no differentiated alimentary apparatus or but a very rudimentary one."\*

On account of their jelly-like nature they are difficult of preservation in a fossil state, and, when found, present a structure which can only be examined by means of microscopic sections. Only two orders have as yet been found fossil in this vicinity, and these only in limited numbers. The first contains one genus and one species, and was formerly placed with the Polypi. The second includes eight genera and eighteen species. The following is the first attempt which has been made to collect the descriptions of genera and species and arrange them in any order:

## Sub-kingdom PROTOZOA.

## Order. FORAMINIFERA.

Minute, structureless, gelatinous animals, with the body protected by a shell generally composed of carbonate of lime. Pseudopodia long, filamentous, and interlacing.

Living *Foraminifera* are microscopic, and distributed in immense beds at the bottom of the ocean. As fossils they are found through all the formations from the Silurian to the Quaternary. They go largely toward making up the chalk formation, and in the Eocene Tertiary formed beds known as the Nummulitic limestone, which stretch from Western Europe to the frontiers of China (Nicholson). Only one genus seems yet to have been found in the Cincinnati group, although both *Receptaculitis* and *Stromatopora*, have been referred here. The genus now placed in this order is BEATRICEA, and it has been assigned various posi-

\*Nicholson Manual of Zoology, p. 44.

tions by different authors. It was originally described as a plant; then grouped with the corals; Prof. Hyatt, in 1865, called it a mollusk allied to the Cephalopoda, and in 1884 considered it as one of the Foraminifera.

Genus 1. BEATRICEA, Billings, 1857.

Rept. Prog. Geol. Sur., Canada, 1852 56; Toronto 1857, p. 343.; A. Hyatt, Jr., 1865 Am. Jour. Arts and Sciences, 2d Series, XXXIX, p. 261 *et seq.*, Pro. Am. Asso. Adv. Sci., XXXII, (1884), p. 492.

Nearly straight, one to fourteen inches in diameter, perforated by a cylindrical and nearly central tube, which is transversely septate; outside of tube composed of numerous concentric layers.

1. B. NODULOSA, Billings, 1857.

*Loc. cit.* p. 343.

Surface covered with oblong, oval, or sub-triangular projections one to three lines high, with rounded, blunt points nearer one end of the prominence than the other; projections varying in size, sometimes with a nearly circular base, sometimes six or seven lines long and one-half as wide, distant one to three lines from each other, arranged in rows or spirals; whole surface fretted with minute points, showing perforations when worn. Septa thin, very concave, one line to one inch apart.

Locality. Originally described from Canada. Found in Marion County, Kentucky.

2. B. UNDULATA, Billings, 1857.

*Loc. cit.* p. 344.

Surface sulcated longitudinally by short, irregular, wave-like furrows, from two lines to one inch across; otherwise like the preceding. Specimens have been found ten feet five inches long and from eight to fourteen inches in diameter.

Locality. With the preceding.

These two species have, by some writers (Knott, Geology of Marion County--Kentucky Geological Survey, p. 32) been considered one species. Prof. Hyatt, however, considers them distinct, and says they can be separated by the internal characters.



## Order. SPONGIDA.

One of the lowest orders of animal life, consisting of an aggregation of animalculæ forming a soft mass with spiculæ of various forms, or possessing a silicious skeleton filled with sarcode. This sarcode is traversed by tubes of varying size, serving to convey nourishment to the individuals.

As fossils, they occur in amorphous masses of irregular shape and variable size, showing little or no structure on the exterior beyond the tube openings or osculæ, internally often of layers of matter separated by interlamellar spaces, the tubes penetrating these vertically. The internal structure can only be studied by means of thin sections, examined under the microscope.

The remains of a number of genera have been found in the rocks of the Cincinnati Group. The ten described genera are here reduced to eight, but no account is taken of those which have been named and not described. The following keys and descriptions are offered as a contribution to the study. The number of species will no doubt be increased on a further study of more material.

## SYNOPSIS OF GENERA.

## I. FREE, IRREGULAR OR SPHERICAL: EXTERNAL OPENINGS TO PORES MINUTE OR WANTING.

*a. Surface without plates.*

Round, unattached, with minute external pores.

1. *Astylospongia*.

Irregular, generally compressed, and having the appearance of a number united in a cluster.

Body circular, with arms.

2. *Pattersonia*.3. *Brachiospongia*.*b Surface covered with plates.*

Having an apparent base: plates polygonal or hexagonal, without special arrangement.

4. *Pasceolus*.

Plates imbricated, arranged in concentric, intersecting lines.

5. *Ischadites*.

Plates cylindrical, blunt; arranged in concentric lines.

6. *Receptaculites*.

## II. INCRUSTING: EXTERNAL PORES CONSPICUOUS.

Formed of thin layers or laminæ; pores with external openings (osculæ).

7. *Stromatopora*.

Formed of thin, irregular laminæ; tubes without walls, perforating laminæ and interspaces, but not continuously.

8. *Stromatocerium*.

Genus 1. ASTYLOSPONGIA, Roemer. 1860. Die Silur. Fauna des West Tenn., p. 7.

*Microspongia*, Miller and Dyer. 1878. Jour. Cin. Soc. Nat. Hist., I., p. 37.

Globular, nearly regular, free: large canals running from the center outward, intersecting smaller, concentric canals: internal structure stellate, the rays cohering; spiculæ (?) small, star-like objects in the midst of the mass.

1. A GREGARIA, Miller & Dyer.

*Microspongia gregaria*, M. & D. 1878. J. C. S. N. H., vol. I., p. 37; pl. 2, fig. 2.

*Chaetetes subrotundata*, U. P. James, 1878. The Palæontologist, p. 1.

*Astylospongia subrotundata*, U. P. James. Ibid, p. 11.

Globular, compact, sometimes as if two or three united into a cluster: one-quarter to three-quarters of an inch in diameter: needle-shaped spiculæ (?) visible under high magnifying power.

Locality: Cincinnati; Ogden Station, Clinton County, Ohio.

The characters given for *Microspongia* are not sufficient to separate it from *Astylospongia*. *A. subrotundata*, James, was first referred to *Chaetetes* (as above), but afterward placed in *Astylospongia*.

2. A. TUMIDA, U. P. James, 1878. The Palæontologist, p. 1.

Sub-globose, depressed, with a cavity on one side; surface rough, pitted, sometimes lobed.

Locality: Cincinnati.

Genus 2. PATTERSONIA, S. A. Miller. 1882. Jour. Cin Soc. Nat. Hist., vol. V., p. 43.

A solid, amorphous mass of uniform structure, and destitute of openings: surface irregular; often appearing as if several specimens were united in a cluster.

P. DIFFICILIS, S. A. Miller. Ibid. p. 43. Pl. 2, figs. 3, 3 a.

Character of the genus. The only species known. It may, on further examination, prove to be a *Stromatopora*.

Locality: Cincinnati, O.

Genus 3. BRACHIOSPONGIA, Marsh, 1867. Am. Jour. Sci. and Arts. Series 2, vol. XLIV., p. 88.

Body nearly hemispherical; arms extending out from lateral surface; hollow, with arms opening into the body cavity.

## 1. B. DIGITATA, Owen.

*Scyphia digitata*, Owen. Second Report on Geology of Kentucky, p. 111.

Body hollow, cup-shaped, with from eight to eleven tubes or arms: arms extending horizontally one inch, and then rising vertically; body six to twelve inches in diameter.

Locality: Frankfort, Ky.

This is probably a Trenton species, and is not likely to be found in this locality. It is inserted here because it has been included in catalogues of the fossils of this group.

## 3. B. TUBERCULATA, U. P. James. 1879. The Palæontologist, p. 25.

Body sub-circular, with prominent tubercles irregularly distributed over the surface; arms, nine, straight; one, to three and a half inches long; specimens between five and six inches in diameter.

Locality: Todd's Fork, near Wilmington, Ohio.

Two other species, viz., *B. lyoni*, Marsh, and *B. roemeriana*, Marsh, though given in catalogues, seem never to have been described. These names can not, therefore, hold.

Genus 4. PASCEOLUS, Billings. Report of Progress of Geological Survey of Canada, 1853-56, p. 342. Palæozoic Fossils of Canada, 1861, p. 392. S. A. Miller, 1874, Cin. Quar. Jour. Sci., vol. I., p. 4.

Ovate or sub-globular. Exterior surface marked by pentagonal or hexagonal plates; base with or without point of attachment.

1. P. GLOBOSUS, Billings. *Loc. cit.*, p. 343. Palæozoic Fossils, p. 392, figure.

Hemispherical or sub-globular: two or three inches in diameter; base flattened; plate impressions polygonal or hexagonal, without external orifices, and about two lines in diameter.

Locality: Cincinnati; Ottawa, Canada.

This is mainly a Trenton species. It has been found in this vicinity in a few localities.

## 2. P. DARWINII, S. A. Miller. 1874. Cin. Quar. Jour. Sci., I., p. 5, fig.

*P. claudii*, S. A. M. Ibid., p. 6, fig.

Body spherical or hemispherical; some specimens with a circular central depression; surface marked with crowded pentag-



gonal or hexagonal plates, one line or less in diameter; diameter of fossil from one-half to one and one-quarter inch.

Locality: Cincinnati, O.; Maysville, Ky.

The form described as *P. claudii* is apparently a young and small specimen, without the circular depression.

Genus 5. ISCHADITES, Murchison. 1839. Siluria, p. 697.

*Lepidolites*, Ulrich. 1879. Jour. Cin. Soc. Nat. Hist., vol.

II., p. 20.

Ovate, conical or cylindrical, often compressed; outer surface, with plates arranged in concentric, intersecting lines, like the engine turning on a watch case.

I. DICKHAUTI, Ulrich. J. F. James, J. C. S. N. H., VIII., p. 163.

*Lepidolites dickhauti*, Ulrich. 1879. Jour. Cin. Soc. Nat. Hist., vol. II., p. 21, pl. 7, figs. 17, 17 *a* and *b*.

*L. elongatus*, Ulrich. 1879. Ibid, II., p. 22, pl. 7, fig. 16.

Compressed from a spherical or sub-pyriform body, with lower portion indented; plates imbricated, about three times as long as wide, with widest end round, exposed, and arranged in concentric, intersecting lines.

Locality: Covington, Ky., about 150 feet above low water mark.

Genus 6. RECEPTACULITES, De France. 1827. Dict. Sci. Nat., t. 45, atlas; p. 68.

*Anomaloides*, Ulrich. 1878. Jour. Cin. Soc. Nat. Hist., vol. I., p. 92.

Hollow, sometimes cup-shaped, with plates radiating in curved lines as in ISCHADITES; numerous cylindrical bodies between the outer plates and the inner, thin, expansion,

R. RETICULATUS, Ulrich. J. F. James, Jour. Cin. Soc. Nat. Hist., vol. VIII., p. 165,

*Anomaloides reticulatus*, Ulrich. 1878. J. C. S. N. H., vol. I., p. 92, pl. 4, figs. 6, 6 *a b*.

Compressed, hollow; formed mainly of elongated, cylindrical bodies, sharp at the inner and rounded at the outer ends; arranged in intersecting lines.

Locality: Covington, Ky.

This and the preceding species were long of uncertain position. There seems little doubt but that they are here referred to

their correct genera. Compare with Billings "On RECEPTACULITES" (Palæozoic Fossils of Canada, I., p. 378) and Hinde in Jour. Geol. Soc., Lond. Nov. 1884. p. 395, et seq.

Genus 7, STROMATOPORA, Goldfuss. 1826. Petrefacta Germaniæ. Nicholson & Murie. 1877. Jour. Linn. Soc. of London. Zoology, XIV., p. 217. Geol. of Ohio, Palæont. vol. II., p. 245.

*Dystactospongia*, S. A. Miller. 1882. Jour. Cin. Soc. Nat. Hist., vol. V., p. 42.

"Skeleton ('sarcodeme') consisting of concentric calcaerous laminae, separated by distinct 'interlaminar spaces,' which are crossed by numerous 'radial pillars.' In some cases there are radiating water canals and surface grooves placed round minor centers. Sometimes there are seen on the surface the openings of large water canals ('oscula').

"Forming irregular masses, sometimes with a foreign body as a nucleus; spreading out into extended expansions, covered inferiorly by a thin, striated, calcareous membrane ('epitheca'), or growing in thin layers parasitically upon foreign objects." Nich. and Murie on "Stromatopora and its allies." Ibid.

The position of this genus has been the subject of much controversy, and the matter is by no means yet settled. It has been placed with the Polyps and with the sponges, but late writers are inclined to regard it as the type of a separate order. See Nicholson and Murie, Ibid, and others. The following is an arrangement of the species of this group:

*a. Massive forms.*

1. S. INSOLENS, S. A. Miller.

*Dystactospongia insolens*, S. A. Miller. 1882. Jour. Cin. Soc. Nat. Hist., vol. V., p. 43, pl. 2, figs. 2, 2 *a b*.

Massive, irregular in form; outer surface, with radiating canals; internal structure minutely vesicular.

Locality: Cincinnati.

This species closely resembles *S. granulata*, Nicholson and Murie, as described and figured by them in the article referred to above. See their figure, Pl. 1, fig. 11.

*b. Tubular forms.*

2. S. TUBULARIS, U. P. James. 1884. Jour. Cin. Soc. Nat Hist., VII., p. 139, pl. 7, figs. 3, 3 *a b*.



Cylindrical or tubular, two, to two and one half inches in diameter, and one inch long; laminae about one-twentieth of an inch in thickness, irregular, wavy, with serrate edges; interspaces thin; pores (oscula) at irregular intervals; center of the tube filled with clay, broken shells, or corals.

Locality: Cincinnati; Morrow, O.

3. *S. SUBCYLINDRICA*, U. P. James. 1884. Jour. Cin. Soc. Nat. Hist., vol. VII., p. 20, figs. 1, 1 *a*, *b*, *c*.

*Lebechia montifera*, Ulrich. 1886. Contr. to Palæon, Vol. I., p. 33, pl. 2, figs. 9, 9 *a b*

Subcylindrical; exterior surface covered with prominent conical elevations, one-tenth to one-twentieth of an inch high, irregularly distributed; apices and slopes of these with radiating lines or depressions; spaces between the monticules covered with circular or elongate papillae, one-twentieth of an inch apart; no surface pores; specimens, two and one-half inches long, curved.

Locality. Morrow and Clarksville, O.; Madison, Ind.

For the resemblances between this species and *Lebechia montifera*, see J. C. S. N. H., IX., No. 2, p. 39.

*c. Incrusting forms.*

4. *S. LICHENOIDES*, U. P. James. 1878. The Palæontologist, p. 18.

Expansions thin, on shells; one-eighth to one-quarter of an inch in diameter and one-quarter to one-half line in thickness; surface rugose or undulating, with small, irregular pores.

Locality: Cincinnati.

5. *S. SCABRA*, U. P. James. 1878. The Palæontologist, p. 18.

Expansions (on shells) thin; surface rough, with conical or elongated monticules, one half to one line above the surface and one to two lines apart.

Locality: Lebanon, O.

6. *S. PAPILLATA*, U. P. James. 1878. The Palæontologist, p. 1.

Crust thin; surface, with small, closely set papillae, irregularly arranged, six or eight to a line; apices open or closed.

Locality: Cincinnati; Clinton County, O.

7. *S. LUDLOWENSIS*, U. P. James. 1884. Jour. Cin. Soc. Nat. Hist., vol. VII., p. 140; figures.

Expansions two by four inches; incrusting or in irregular, amorphous masses; surface irregular or rough; laminae thin; pores

circular or oval, irregularly distributed; numerous minute pores, and a greater or lesser number of larger oscula.

Locality: Ludlow, Ky., etc.

This species shows there is no definite line to be drawn between the massive and incrusting species of the genus.

Genus 8. STROMATOCERIUM, Hall. 1847. Pal. of New York, vol. I., p. 48; emended by Nicholson and Murie, Jour. of Linn. Soc., London (Zoology), 1877, Vol. XIV., p. 222.

Skeleton massive, composed of dense, thick, calcareous, horizontal and concentric laminæ, separated by narrow and irregular interspaces; laminæ irregularly disposed; no radial pillars crossing interlaminar spaces; entire mass perforated by vertical tubes without walls, at short and irregular distances; the tubes place the interlaminar spaces in communication, but cannot be said to run from top to bottom.

1. S. CANADENSE. Nich. & Murie, 1877. Ibid, vol. XIV., p. 223, pl. 3, figs. 9, 10.

*S. rugosum*. (?) Hall, 1847. Pal. of N. York, vol I. p. 48, pl. fig.

"Skeleton having the form of large, rounded or irregular masses, conspicuously composed of numerous dense, concentric laminæ, about five of which (with the interlaminar spaces) occupy one line. The interlaminar spaces are open, without radial pillars and the mass is traversed by numerous discontinuous, vertical canals, from  $\frac{3}{16}$  to  $\frac{1}{8}$  inch or less in diameter. Surface characters unknown."

Locality: Peterborough, Ontario.

2. S. RICHMONDENSE, S. A. Miller. 1878. Jour. Cin Soc. Nat. His., vol. V., p. 41, pl. 2, figs. 1, 1 a b.

Small, globular, hemispherical, irregular; laminæ irregular, more or less wrinkled, filled with minute tubes. surface apparently destitute of openings.

Locality: Richmond, Ind.